

Patent Claims

1. Method for purification of contaminated water by hydrate formation and separation of hydrates from contaminated water enriched with contaminants,
5 characterized in that the method comprises supplying hydrate particles to the water during hydrate formation.

2. Method according to Claim 1,
characterized in that the method further comprises the handling of the
10 contaminants which have been separated off.

3. Method according to Claim 1,
characterized in that the contaminants comprise one or more components selected from the group consisting of hydrocarbons, organic and inorganic
15 salts, dust, mud, metals, sand, gas, radioactive compounds, and biological material.

4. Method according to Claim 1,
characterized in that the contaminants which have been separated off
20 are handled by recirculation to upstream process steps or deposition/disposal.

5. Method according to Claim 1,
characterized in that the method comprises the following steps:
25 a) supply of hydrate forming compound and hydrate seeds to the water;
b) formation of hydrates under suitable pressure and temperature conditions;
c) harvesting of the hydrates from contaminated water;
d) dissociation of the hydrates to pure water and hydrate forming compound.

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6. Method according to Claim 5,
characterized in that hydrate formation is carried out in several steps by
subjecting the contaminated water from step c) to repeated hydrate formation

processes in series until the concentration of contaminants in the contaminated water is too high for further hydrate formation.

7. Method according to Claim 6,

5 characterized in that the concentration of contaminants in the contaminated water is at least 10 % by weight, preferably at least 12 % by weight, more preferably at least 15 % by weight, at the end of the process.

8. Method according to Claim 5,

10 characterized in that the harvested hydrates from step c) are subjected to a washing step prior to dissociation to pure water and hydrate forming gas.

9. Method according to Claim 5,

15 characterized in that the hydrate forming compound supplied in step a) is selected from lower hydrocarbons, CO₂, halogenated hydrocarbons, wherein halogen is selected from chlorine and fluorine, tetrahydrofuran, ethylene oxide, noble gases selected from helium, neon, argon, xenon, krypton, sulphur hexafluoride, dinitrogen oxide, preferably C₁-C₅ hydrocarbons or CO₂, more preferably methane, ethane, propane, CO₂, most preferably methane or CO₂.

20 10. Method according to Claim 1,

characterized in that the pressure and temperature conditions are:

T < 30°C, P > 1 bar, preferably T < 20°C, P > 5 bar, most preferably T < 10°C, P > 20 bar.

25 11. Method according to Claim 1,

characterized in that the hydrate particles are supplied by recirculation of hydrates from step c).

30 12. Method according to Claim 1,

characterized in that the hydrate particles which are supplied to the hydrate formation step have a diameter of maximum 3 mm, preferably maximum 500 µm, still more preferably maximum 100 µm.

13. Method according to Claim 5,
characterized in that harvesting of the hydrates in step c) takes place in
a conventional separation process.

5 14. Method according to Claim 13,
characterized in that the hydrate harvesting process is selected from the
group consisting of sedimentation, filtration, centrifugation, flotation.

15. Method according to Claim 5,
10 characterized in that the hydrates dissociate through an increase in
temperature and/or reduction in pressure.

16. Method according to Claim 5,
characterized in that the pure water from step d) is adequately pure to
15 be used as drinking water or can be discharged.

17. Method for purification of gas,
characterized in that the gas is bubbled through water for transfer of
gaseous contaminants to the water, prior to the water being subjected to a
20 method for purification of water according to Claim 1.

18. Device for purification of contaminated water,
characterized in that the device comprises

- 25 a) unit for mixing of hydrate forming compound, hydrate seeds and
contaminated water under cooling and pressurization;
b) device for harvesting the hydrates from contaminated water;
c) device for dissociation of the hydrates in pure water and hydrate forming
compound.

30 19. Device according to Claim 18,
characterized in that it further comprises additional devices according to
Claim 18 in series in a sufficient number to obtain a satisfactory concentration
increase of the contaminants.

20. Use of a device for purification of water according to Claim 13, for purification of produced water during recovery of hydrocarbons.

21. Device for purification of air/gas,

5 characterized in that the device comprises:

- a) unit for transfer of gaseous components from the gas to be purified, to water;
- b) unit for mixing hydrate forming compound, hydrate seeds and contaminated water under cooling and pressurization;
- 10 c) device for harvesting the hydrates from contaminated water;
- d) device for dissociation of the hydrates in pure water and hydrate forming compound.

22. Water,

15 characterized in that it has been purified by a method according to Claim 1.

23. Air/gas

20 characterized in that it has been purified by a method according to Claim 1.